AMENDMENTS TO THE SPECIFICATION

After the last paragraph of page 6, please insert the following:

FIG. 7 is a block diagram of a circuit for detecting frequency and timing error and corresponds to FIG. 3 of KPA 1999-0042903.

FIG. 8 represents an apparatus for detecting frequency and timing error and corresponds to FIG. 4 of KPA 1999-0042903.

FIG. 9 represents another apparatus for detecting frequency and timing error and corresponds to FIG. 5 of KPA 1999-0042903.

FIG. 10 is a graph showing frequency error detection output based on Equation 6 and corresponds to FIG. 6 of KPA 1999-0042903.

FIG. 11 is a graph showing frequency error detection output based on Equation 7 and corresponds to FIG. 7 of KPA 1999-0042903.

Please change the paragraph bridging pages 7 and 8 as follows:

The device for detecting the frequency and timing error 10 is described in detail in [[U.S.]] Korean Patent Application No. ~~09/042,903~~ 1999-0042903 filed Oct. 5, 1999, entitled "Device for Detecting Frequency and Timing Error in Communication System", which is incorporated herein by reference. The device for detecting the frequency and timing error 10 includes a first band-pass filter 201, a second band-pass filter 202, a third filter 204 and a fourth filter 205. Here, the first and second band-pass filters 201 and 202 serve to decrease a pattern jitter of the device for detecting the frequency and timing error 10, and thus are not essentially required.

After the paragraph bridging pages 7 and 8, please insert the following:

FIG. 7 (FIG. 3 of KPA 1999-0042903) is a block diagram of a circuit for detecting frequency and timing error, which adopts an apparatus for detecting frequency and timing error in a communication system according to an embodiment of the present invention.

As shown in FIG. 8 (FIG. 4 of KPA 1999-0042903), the apparatus for detecting the frequency and timing error in the communication system according to an embodiment of the present invention, includes first and second band pass filters 401 and 402, third and fourth filters 403 and 404, first, second, third, and fourth multipliers 405, 406, 407, and 408, and first and second adders 409 and 410.

The first and second band pass filters (h(t)) 401 and 402 have the center frequency of 1/2T (T is a symbol interval). The third and fourth filters ($h_d(t)$) 403 and 404 have differential characteristics in the analog implementation, or half symbol-period delay circuits or Hilbert filters in the digital implementation.

An input signal S(t) is a baseband complex signal. As for the input signal S(t), a real component is applied to the first band pass filter 401, and an imaginary component is applied to the second band pass filter 402.

The input signal S(t) can be expressed as Equation 1 (Equation 2 of KPA 1999-0042903).

[Equation 1]

$$\begin{aligned} s(t) &= e^{j2xf_d t} \sum_i c_i g(t-iT) \\ &= \sum_i \mathrm{c}_i e^{j2xf_d iT} g(t-iT) e^{j2xf_d (t-iT)} \\ &= \sum_i \mathrm{d}_i g(t-iT) e^{j2xf_d (t-iT)} \end{aligned}$$

wherein $d_i = c_i e^{j2xf_d iT}$.

The real and imaginary components of the input signal s(t) as shown in Equation 1, are separated and passed through the first and second band pass filters 501 and 502, respectively. A resultant output is given by Equation 2 (Equation 3 of KPA 1999-0042903).

[Equation 2]

$$\begin{aligned} x_1(t) &= x_{1c}(t) + fx_{1s}(t) \\ &= \sum_i d_i g(t-iT)e^{j2xf_d(t-iT)} * h(t) \\ &= \sum_i d_i q_1(t-iT) \end{aligned}$$

wherein $q_1(t) = g(t)e^{j2xf_d'} * h(t)$.

An output from the first and second filters 503 and 504 is given by Equation 4 (Equation 2 of KPA 1999-0042903).

[Equation 3]

$$\begin{aligned} x_2(t) &= x_{2c}(t) + fx_{2s}(t) \\ &= \sum_i d_i g(t-iT)e^{j2xf_d(t-iT)} * h(t) * h_d(t) \\ &= \sum_i d_i q_2(t-iT) \end{aligned}$$

wherein $q_2(t) = g(t)e^{j2xf_d'} * h(t) * h_d(t)$.

The multiplication value of the output of the first filter 403, which is the real component in Equation 3, and the output of the first band pass filter 401, which is the real component in Equation 2 is added at the second adder 410 to the multiplication value of the output of the second filter 404, which is the imaginary component in Equation 3, and the output of the second band pass filter 402, which is the imaginary component in Equation 2, to thus acquire $y_c(t)$. The multiplication value of the output of the second filter 404, which is the imaginary component in Equation 3, and the output of the first band pass filter 401, which is the real component in Equation 2, is added at the first adder 409 to the inverted multiplication value of the output of the first filter 403, which is the real component in Equation 3, and the output of the first band pass filter 402, which is the imaginary component in Equation 2, to

thus acquire $y_s(t)$. $y_c(t)$ and $y_s(t)$ are given by Equation 4 (Equation 5 of KPA 1999-0042903).

[Equation 4]

$$\begin{aligned} y(t) &= y_c(t) + fy_s(t) \\ &= x_1(t)x_2^*(t) \\ &= \sum_i d_i q_1(t-iT) \sum_l d_i^* q_2^*(t-lT) \\ &= \sum_i \sum_l d_i d_i^*(t-iT) q_2^*(t-lT) \end{aligned}$$

In Equation 4, an average of outputs for detecting the frequency-timing error is given by Equation 5 (Equation 6 of KPA 1999-0042903).

[Equation 5]

$$\begin{aligned} E[y(t)] &= E[\sum_i \sum_l d_i d_i^*(t-iT) q_2^*(t-lT)] \\ &= \sum_i E[d_i d_i^*] q_1(t-iT) q_2^*(t-lT) \\ &= C_1 \sum_i q_1(t-iT) q_2^*(t-lT) \end{aligned}$$

where $C_1 = E[d_i d_i^*]$.

The separation into the imaginary component and the real component based on Equation 5 can be given by Equation 6 (Equation 7 of KPA 1999-0042903) and Equation 7 (Equation 8 of KPA 1999-0042903).

[Equation 6]

$$\begin{aligned} \operatorname{Im} E[y(t)] = \frac{C_1}{T}[&\int_{-\infty}^{\infty} |G(f-f_d)|^2 |H(f)|^2 \operatorname{Im}[H_d^*(f)]df \\ &+ 2\int_{\infty}^{\infty} \operatorname{Im}[G(f-f_d+\frac{1}{2T})G^*(f-f_d-\frac{1}{2T})H(f+\frac{1}{2T})H^*(f-\frac{1}{2T})e^{\frac{j2xt}{T}}] \\ &\operatorname{Re}[H_d^*(f-\frac{1}{2T})]df] \end{aligned}$$

[Equation 7]

$$\operatorname{Re} E[y(t)] = \frac{C_1}{T}[\int_{-\infty}^{\infty} |G(f-f_d)|^2 |H(f)|^2 \operatorname{Re}[H_d^*(f)]df$$
$$-2\int_{-\infty}^{\infty} \operatorname{Im}[G(f-f_d+\frac{1}{2T})G^*(f-f_d-\frac{1}{2T})H(f+\frac{1}{2T})H^*(f-\frac{1}{2T})e^{\frac{j2\pi t}{T}}]$$
$$\operatorname{Im}[H_d^*(f-\frac{1}{2T})]df]$$

Here, the imaginary component in Equation 6 corresponds to the frequency error detection output, and the real component in Equation 7 corresponds to the timing error detection output.

In FIG. 8 (FIG. 4 of KPA 1999-0042903), in case that it is designed that the first and second band pass filters (h(t)) 401 and 402 are fourth-order IIR filters and the first and second filters ($h_d(t)$) 403 and 404 are Hilbert filters, a S-curve of the frequency error detection output based on Equation 6 is shown in FIG. 6 and a S-curve of the timing error detection output based on Equation 7 is shown in FIG. 11 (FIG. 7 of KPA 1999-0042903) .

It has been illustrated based on the construction of FIG. 8 (FIG. 4 of KPA 1999-0042903) by way of example. Note that a S-curve similar to FIGS. 10 and 11 (FIGS. 6 and 7 of KPA 1999-0042903) can be produced by interpreting another exemplary construction of FIG. 9 (FIG. 5 of KPA 1999-0042903) according to the above-mentioned procedure.

The interpretation of the frequency error detection output and the timing error detection output according to the circuitry of the present invention, produces the S-curves as shown in FIG. 10 and FIG. 11 (FIG. 6 and FIG. 7 of KPA 1999-0042903). It can be seen that the apparatus for detecting the frequency and timing error properly operates.

As set forth above, the circuitry complexity can be reduced by implementing the apparatus for detecting frequency error and the apparatus for detecting the timing error within one circuit.